⊛ 5 Stars

BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

Technical Specification for Cable Entry Type, Star-2 Rated (EEL-2) 11/0.433kV, 3Phase, 50Cycle, Aluminium Wound, CRGO core Distribution Transformer of rating 100kVA, 250kVA and 500kVA.

1.0 SCOPE:

This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing at works before supply of 3 phase, 50Hz, core type, oil immersed self cooled Distribution Transformer confirming to 5 star Rated of IS:1180(Part1):2014 and IS:2026 of 1977as amended from time to time for outdoor use.

It is not the intent to specify completely herein all the details of the design and construction of equipment. However the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of suppliers supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The transformer and accessories shall be designed to facilitate operation, inspection, manufacture and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.

The transformers shall be manufactured strictly as per specification, without any deviations.

2.0 STANDARDS:

The materials shall conform in all respects to the relevant Indian/International Standards, with latest amendments thereof unless otherwise specified herein. Some of them are listed below:

Indian Standard	Title	International and internationally recognised standards
IS:2026/1977 (Parts 1 to 5,8&10)	Specification for Power Transformers	IEC:76
IS:1180 (Part 1):2014	Outdoor distribution transformer up to and including 2500kVA	

IS:12444	Specification for copper rod	ASTM B-49
IS:335/1993	Specification for transformer Oil	BS148, D-1473, D1533-1934, IEC Pub 296
IS:5/1944	Specification for colours for ready mixes colours	
IS:104/1979	Ready mixed paint, brushing zinc chromate, priming	
IS:2099/1986	Specification for high voltage porcelain bushing	
IS:649/1997	Testing for steel sheets and strips and magnetic circuits.	
IS:4257	Dimensions for clamping arrangements for bushings.	
IS:7421	Specification for low Voltage bushings	
IS:3347 (Parts I to IV)	Specification for Outdoor Bushings	DIN 42531 to33
IS:5484	Specification for Al Wire rods	ASTM B:233
IS:9335	Specification for Insulating Kraft Paper	IEC 554
IS:1576	Specification for Insulating Press board.	IEC 641
IS:6600	Guide for loading of oil Immersed Transformers.	IEC76
IS:2362	Determination of water content in oil for porcelain bushing of transformer, by Karl fischer method-test method.	
IS:6162/1971 (Parts I & II)	Paper covered aluminium conductor.	
IS: 6160/1971	Rectangular electrical conductor for electrical machines.	
IS: 5561/1970	Electrical power connector.	
IS:6103/1971	Testing of specific resistance of electrical insulating liquids.	
IS:6262/1971	Method of test for power factor and dielectric constant of electrical insulating liquids.	
IS:6792/1992	Determination of electrical strength of insulating oil.	
IS:10028/1985 (Parts I to III)	Insulating and maintenance of transformers.	
IS: 10028:	Selection, installation & maintenance of transformers	
IS: 3401	Silica gel	
	REC specification No.2	

IS 3024	Grain oriented electrical steel sheets and strips	
IS 191	Copper	
IS 1897	Copper strip for electrical purpose,	
IS 7404(Part1)	paper covered copper conductors	
IS 13730	Specification for winding wires	

Materials conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the suppliers who wish to offer material conforming to other standards, the supplier shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Five copies of such standards with authentic English translations shall be furnished along with the offer.

3.0 SYSTEM DETAILS:

The transformers shall be suitable for outdoor installation with 3Phase, 50 Hz, 11kV System in which the neutral is effectively earthed and the same shall be suitable for service under fluctuations in supply voltage up to 12.5% permissible under Indian Electricity Rules and the frequency variation of -5% and +2% (47.5Hz to 51.0Hz).

4.0 CLIMATIC CONDITIONS:

The material used in the construction of the Distribution transformers shall be suitable for use under the following climatic conditions.

1	Location	BESCOM Area Karnataka
2	Max. ambient air temperature	50° C
3	Max. daily average air temp.	40° C
4	Minimum ambient air temp.	10° C
5	Altitude	1000 M above MSL
6	Maximum Wind Pressure	150 Kg/MSq
7	Relative Humidity	10 to 100%
8	Isoceranic level	5° C (Min.)
9	Avg. annual rainfall	As per IS:45
10	Climate	Tropical Moderately hot and humid

5.0 THE TRANSFORMERS SHALL CONFORM TO THE FOLLOWING SPECIFIC PARAMETER:

Sl No.	Item	11kv Distribution transformers
1.	System voltages (max).	12kV
2.	Rated voltages HV	11kV
3.	Rated voltages (No Load)LV	433-250V
5.	Rated Frequency	50Hz
6.	Phases	Three
7.	Connection HV	Delta
8.	Connection LV	Star (Neutral brought out)
9.	Vector group	Dyn-11
10.	Type of cooling	ONAN as per IS 2026
11.	% of impedance at 75 °C	4.5%
12.	Fault level of the system	750MVA

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed distribution transformer shall be as below (NEMA Standards)

kVA rating	Audible sound levels (decibels)
101-300	55
301-500	56

6.0 TECHNICAL PARAMETERS:

a) **Percentage Impedance**:
The Percentage Impedance shall be 4.5% for transformers of 100kVA, 250KVA and 500KVA as per IS 1180(Part 1):2014 with tolerance as per IS: 2026.

b) **Temperature rise**:

The permissible temperature – rise shall not exceed the limits of 45°C when measured by resistance method for transformer winding and 40°C measured by thermometer for top oil when tested in accordance with IS 2026(Part 2).

e) **INSULATION LEVELS:**

Sl No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)
1	0.433	-	3
2.	11	75	28

6.1 TAPS (for 250kVA and above):

- Tappings shall be provided on the HV voltage windings for variation for HV voltages as under.

  - Voltage Ratio : 11000/433v
  - No. of tap positions : 7
  - Range of variation : +5% to -10% in steps of 2.5% for variation of HV.

- Tap changing shall be carried out by means of an externally operated self position switch and when the Transformer is in de-energized condition.

- Switch position No.1 shall be marked as 1 (High) shall correspond to the maximum voltage tap position switch position No.2 shall be marked as 2 (normal) shall correspond to normal voltage tap position. Switch position 7 shall be marked as 7 (Low) shall correspond to the minimum voltage tap position.
- Each tap change shall result in variation of 2.5% in voltage.
- Provision shall be made for locking the tap switch handle in position.

7.0 DESIGN & CONSTRUCTION:

7.1 Core:

a) The core shall be of high grade CRGO steel sheet *of* 23HP90 Grade or superior Grade having low loss and non ageing grain oriented, coated with hot oil proof insulation, bolted together to the frames firmly to prevent vibration or noise. All core clamping bolts shall be effectively insulated.

The complete design of core must ensure permanency of the core losses with continuous working of the transformers. The value of the flux density shall not be more than 1.7 tesla at 50 HZ and maximum specific core loss shall not be more than 0.9 watts per kg.

The maximum flux density in any part of the core and yoke at rated voltage and frequency shall be such that the flux density with +12.5% combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.

The construction of core, internal clearances minimum effective area of cross section, minimum Nos. of core steps etc., shall be strictly as per the drawings.

b) The transformers core shall not be saturated for any value of V/F ratio to the extent of 112.5% of the rated value of V/F ratio i.e., 11kV/50Hz. (Due to combined effect of voltage and frequency) upto 12.5% without injurious heating at full load conditions the core shall not be saturated.

The Supplier shall furnish necessary design data in support of this condition

c) The maximum thickness of core laminations shall not be more than 0.23mm. Further the lamination sheets used for top yoke, bottom yoke etc., shall be of single piece.

d) No load current, shall be measured by energizing the transformers at 433 volts 50 C/S on the secondary for distribution transformers. Increase of voltage by 10% shall not increase the no load current disproportionately high. Test for magnetic balance by connecting the LV phase by phase to rated phase voltage and measurement of an, bn, cn, voltage shall be carried out. The no load current shall not exceed 2% in respect of 100kVA, 250KVA and 500KVA at rated voltage and for rated frequency. Increase of 12.5 % of rated voltage shall not increase the no load current by 5% of full load current.

The minimum

(1) Effective core area
(2) Number of core steps
(3) Internal clearance

Minimum effective cross sectional area of the core to be provided are as follows:

1) 100kVA - 107.30 sq.cm.
2) 250KVA - 170.30 sq.cm.
3) 500KVA - 244.20 sq.cm.

Note: If the manufacturer uses the better quality CRGO steel for the core the manufacturer has to furnish the area of cross section of the core along with the design details.

e) The unbalance current in the neutral shall not be more than 2% of the rated current.

7.2 CORE CLAMPING:

1) M.S. Channel 125 x 65mm for 500KVA, 100x50mm for 250 KVA & 75x40mm channel on top and bottom shall be used for clamping the core.

2) 2 Nos. of 12mm high tensile vertical bolts in parallel in each side shall be provided. The size of the Bolts to be provided in parallel are as follows:

a) 100kVA - 2 Nos. of 12mm High Tensile Bolts.
b) 250 KVA - 2 Nos. of 16mm High Tensile Bolts.
c) 500 KVA - 2 Nos. of 20mm High Tensile Bolts.

3) Channel on LV side to be reinforced at equidistance if hole cutting is done for LT lead so as to avoid bending of channel.

4) M.S. Channels are to be painted by varnish and corrosion oil resistant paint before use.

5) Flat or cut channel shall not be used.

6) Core mounting is to be done with ISF 50x10 for 100kVA and 50X16 for 250KVA & 500KVA transformer.

7) Clamping arrangement should be strong enough to withstand mechanical forces. The mechanical strength shall be proven by short circuit test.

7.3 TIE BOLTS:

Four horizontal tie rods (or high tensile steel) of Rods of dia 12mm for 100kVA,16mm for 250KVA and 20mm for 500KVA to be used. Rods to be effectively insulated with kraft paper tube of thickness I.5mm.

i) All top and bottom Yoke nuts bolts and tie rods shall be painted with oil and corrosion resistant paint before use.
ii) Channel - (top yoke) on LV side to be reinforced at equidistance if hole cutting is done to avoid bending of channel.
iii) The flat provided at the core shall be as per the drawings enclosed and shall not be cut through the length.
iv) Tie rods shall be effectively earthed.
v) Drawing of the building of the core shall be got approved before start of the work

7.4 WINDINGS:

The winding of the transformers shall be connected in delta on the primary side and in star on the secondary side, so as to produce, a positive phase displacement of 30 degrees from the primary to the secondary vectors of the same phase. The neutral of the LT windings shall be brought out to a separate terminal. The vector group shall be Dyn.11.

a) **Material-** Double layer paper covered Aluminium conductor shall be used.
b) The nominal HV winding cross section shall be as follows:

SL. No.	Rating	
1	100kVA	4.524 Sq.mm
2	250KVA	17.65 Sq.mm.
3	500KVA	33.89 Sq.mm.

c) The nominal LV winding cross section shall be as follows:

SL. No.	Rating	
1	100kVA	159.32 Sq.mm
2	250KVA	293.56 Sq.mm.
3	500KVA	719.28 Sq.mm.

d) LV winding shall be in even layers

e) The neutral formation shall be at top

f) **Note:** If the manufacturer use the appropriate HV/LV winding cross sections less than the above mentioned values so as to comply with the maximum losses at 50% load and at 100% load and the temperature rise limits specified in IS 1180. The design details shall be furnished along with the GTP for approval.

7.5 LOSSES & IMPEDANCE:

The losses and impedance for various ratings of transformers of 11KV class shall be within the permissible limits. These losses are the maximum permissible.

Rating (KVA)	**Max Losses at 50% loading (watts)**	**Max Losses at 100% loading (watts)**	Impedance % (subject to tolerance as per IS:2026)
100	435	1500	4.5
250	920	2700	4.5
500	1430	4100	4.5

1. TOLERANCE:

No positive tolerance shall be allowed on the maximum losses mentioned above for both 50% and 100% loading values.

2. PENALTY FOR NON PERFORMANCE:

During testing at supplier's works, if it is found that the actual measured losses are more than the values quoted by the supplier, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.

Purchaser shall reject the entire lot during the test at suppliers works, if the temperature rise exceeds the specified values.

Purchaser shall reject any transformer during the test at suppliers works, if the impedance values differ from the guaranteed values including tolerance.

7.6 INSULATION, INSULATION MATERIAL & CLEARANCES:

a) Press board blocks at top and bottom of each coil assembly shall be provided. There must be atleast 4 blocks per phase/coil of each of thickness of 5mm. Core wrapper shall be of minimum of 1mm thick.

The channel at phase barrier board shall be of 2mm thick press board. The tie rod insulation kraft paper shall be of thickness 1mm. Between HV and LV windings addition press Board cylinder of at least 2mm in addition to spacers shall also be provided.

b) No. of vertical/ axial wedges for 100kVA, 250 KVA & 500KVA minimum 18Nos. shall be provided depending upon the capacity of transformers between LV and HV windings and equispaced around LV. The wedge shall be minimum 6.5mm thick and 8-12mm wide.

c) The inter layer insulation shall be provided between HV windings layers depending on the design. The details shall be furnished.

d) The Neutral connection of LT winding shall be formed using aluminium strip of same size as that of 'S' type link of size 25x3mm for 100kVA, 40x5mm for 250KVA and 70x5 mm for 500KVA transformers.

e) The Delta formation of HV winding shall be made using copper jumper leads of size 1.65MM for 100kVA, 2.65MM for 250KVA and 3.75 MM for 500KVA transformers. The leads shall be enclosed in Kraft insulated paper tube.

f) Double paper covering shall be used for winding insulation both for HV & LV windings. Either performed corrugated cylindrical boards or cylindrical compressed boards with spacers shall be provided between HV & LV windings. Press board of type - D IS: 1576 to be used for top and bottom yoke insulation. The electrical grade insulating paper shall be of triveni/Ballarpur or equivalent make subject to approval of BESCOM. Press boards used shall be of M/s. Senapathi whitely or M/s. Raman Boards or equivalent make subject to approval of BESCOM.

g) Radial clearance of LV coil to core (bare conductor) shall not be less than.

1. for 100kVA - 4.5MM.
2. for 250KVA - 5.0MM.
3. for 500KVA - 5.0MM.

h) Radial clearance between HV and LV coils shall not be less than 10mm for all capacities.

i) Phase to phase clearance between HV coils shall not be less than 15mm. A minimum of 2 Nos. of 1mm press board shall be used to cover the tie rods.

j) The minimum electrical clearance between the winding and body of the tank (between inside surface of the tank and outside edge of the winding) shall not be less than 30mm.

k) End insulation to earth shall not be less than 25mm.

l) HV & LV coils single coil multi layer winding shall be used for all capacities of transformers.

m) Tap lead shall be insulated with 1.5 mm thick paper insulation. Inspection of windings prior to tankings shall be done. Manufacturing drawing for the transformer showing various clearances shall have to be approved by the BESCOM.

8 TANK:

The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

All joints of tank and fittings shall be oil tight and no bulging should occur during service.

Inside of tank shall be painted with varnished/hot oil resistant paint.
Top cover of the tank shall be slightly slopping to drain rain water.

The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

The rating and serial no's. of the transformer shall be embossed/punched on the tank of transformer/ on transformer name plate fitting sheet of the transformer. In addition to name plate details of transformer fitted to the transformer tank.
Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the BESCOM.
The transformer tank shall be of robust construction only in rectangular/ Octagonal shape and shall be built up of electrically tested welded mild steel top and bottom plates thickness of 5.00 mm and 3.15 mm for the side wall thickness.

Suitable reinforcement by welded angle shall be provided on all the outside walls on the edge of the tank. The permanent deflection shall not be more than 5mm up to 750mm length and 6mm up to 1250mm length and 8mm up to 1750mm length when transformer tank without oil is subjected to Air pressure test as per IS:1180.

Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/sq.cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS:1747.

1) Plain tank shall be capable of withstanding a pressure of 80kPa and a vacuum of 500mm of mercury without any deformation.
2) **Lifting lugs:**
   4 Nos.of welded heavy duty lifting lugs of M.S. Plate 8mm thick suitably reinforced by vertical supporting flat welded edgewise below the lug on the side wall shall be provided.
3) **Pulling Lugs:**
   4 Nos. of welded heavy duty pulling lugs of M.S plate 8 mm thick shall be provided to pull the transformer horizontally,

4) **Top Cover Fixing Bolts & Gasket:**

- The bolts/nuts shall be size 12mm x 40mm with one plain and one spring washer suitably apart (100mm) to press the cover shall be of stainless steel.

- Gaskets shall be made of Synthetic rubber or synthetic rubberised cork resistant to hot transformer oil confirming to IS:11149/Type C as per IS-4253 Part-II shall be placed between top cover plate and tank.

5) Tolerance on tank dimensions shall be limited to -5% to + 10%.

9 HEAT DISSIPATION:

a) Heat dissipation by tank walls excluding top and bottom should be 500 watts / Sq. mtr.

b) Heat dissipation by radiator 1.25mm thick shall be considered for heat dissipation calculation. The tenderer shall submit the calculation sheet along with No. of radiators to be provided and type of fixing radiators to the transformer tank.

c) The guaranteed temperature rise of oil and winding shall be found by conducting temperature rise test in presence of the representative of the BESCOM.

10 TOTAL (APPROX) OIL VOLUME:

Sl. No.	Rating	Oil in Ltrs. (inclusive for oil absorbed in core coil assembly)
1	100kVA	230
2	250KVA	500
3	500KVA	700

NOTE: If the absorption of oil in the core and winding assembly is more than permissible value first filling oil volume should be increased accordingly detailed calculation of absorption shall be submitted.

11. CONSERVATOR:

Conservators shall be provided on transformers of rating 100kVA, 250KVA and 500KVA

When a conservator is fitted, the oil gauge and the plain or dehydrating breathing device shall be fixed to the conservator which shall also be provided with a drain plug and a filling hole (1¼ nominal size thread) with cover. In addition, the cover of the main tank shall be provided with an air release plug to enable air trapped within to be released. Unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.

a) Prismatic oil level indicator shall be provided on the side which will be fully covered detachable flange with single neoprene gasket and tightended with M.S. bolts and nuts.

b) The inside diameter of the pipe connecting the conservator to the main tank shall be with in 20 to 50 mm and it should project in to the conservator in such a way that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to - 5° C) should be above sump level.

c) The pipe from conservator tank connecting to main tank shall be sloping so that the oil falling from the pipe shall not fall directly on the active parts and shall fall on the side walls only.

d) The conservator shall be provided (except for 25KVA) with the drain plug and filling hole with cover. In addition, the cover of the main tank shall be provided with an air release plug (except for 25KVA).

e) Conservator pipes fixing conservator to the top plate of the transformer should be on either side of metal pocket provided for mounting LT bushings with minimum electrical clearance of 110mm between phases and also earth.

12. BREATHERS :

Breather joints shall be of bolted type. It shall have die cast Aluminium body and inside container for Silicagel shall be of tin. Make of Breathers shall be subject to BESCOM approval.

For 100kVA -250Gram, 250 KVA and 500 KVA transformers 500Grams breather shall be provided.

The breather shall have an inspection window to view the condition of the silicagel.

13. TERMINALS:

a) Brass rods 12mm dia for HT for all the capacities and 14mm dia for LT for 100 KVA, 20mm dia for LT for 250 KVA & 30mm dia for 500KVA transformers shall be provided.

b) Connecting lugs shall be provided confirming to IS: 3347 for LT terminals for all the capacities of Transformers.

c) The metallic connector shall be L type for LT bushing of distribution transformer .

d) The L type clamp shall be suitable to take off two/four circuits of 240 Sq. mm aluminum wire (for 250, 500KVA transformers)

e) The HV and LV windings conductor shall not be terminated to the bushing rod directly.

f) The HV winding shall be linked through a terminal lug and copper jumper lead of size 1.65mm for 100kVA, 2.65mm for 250KVA and 3.75mm for 500KVA transformers. The leads shall be enclosed in kraft paper tube.

g) The LV winding shall be terminated using inverted 'S' type link of size 25x3mm for 100kVA, 40x5mm for 250KVA and 70x5mm for 500KVA transformers.

1) All the leads / links shall be immersed in oil.

2) All the leads/links shall be taken neatly strapped on an insulated press Board/wooden Bus Bar.

14. BUSHINGS:

i. The porcelain of HT and LT bushings shall be of standard make and confirm to IS-2099/1973 (HV), "Specification for High Voltage porcelain bushings" and IS – 7421/1976 for LV IS -3347 shall be outdoor and HT bushing with a minimum creepage distance of 270mm. the bushings rods and nuts shall be made of brass material 12mm diameter for both HT & LT. the bushings shall be fixed to the transformers on sides with straight pockets and in the same plane. The tests as per IS-2099/1962 shall be conducted on the transformer bushings as detailed below.

Dry flashover voltage withstand test
Wet flashover voltage frequency voltage withstand test
Dry I min. withstand voltage
Wet half min. withstand voltage
Impulse withstand voltage (1.2/50 micro seconds positive wave)

ii. On HV side, bushings shall be provided with appropriate current carrying capacity as the rating of the transformer and shall be on sideway of the transformers. The transformers shall be provided with the cable box on HV side. Bushings of plain sheds as per IS:3347 shall be mounted on the side of the tank not on top cover.

iii. Dimensions of the bushings of the voltage class shall conform to the standard mentioned below:

Voltage class	Indian Standards for Porcelain Parts	For metal Parts
1.1kV	IS-3347/part-I/Sec.-I/1965/1979	IS-3347/Part-I/ Sec,I/1979 (As per IS-1180/1989)
17.5kV	IS-3347/Part-III/Sec.I/1972	IS-3347/Part-II/Sec.2/1982

iv. On LV side 1kV class bushing shall be provided with appropriate current carrying capacity as per the rating of the transformer and shall be on sideways of the transformers. The transformer shall be provided with the cable box on LV side.

v. The bushings shall be fixed on sides with pockets in the same plane. Arcing horns shall not be provided and instead brass caps shall be provided.

vi. Brazing of all internal connections – All jumpers from windings to bushing shall have a cross section larger than tile winding conductor. For copper, silver brazing alloy to be used. For aluminium, L&T aluminum brazing rods shall be used.

vii. In the case of LV bushing, the internal bushing shall be made of tough insulating material like epoxy and shall have embedded stem and a strong coupling connection (screwed) properly secured with a split pin/screw type locking arrangement shall be used between stem of the internal and external bushings.

viii. The LV bushings shall be so located that even under the hottest conditions the level of the transformer oil shall be below the opening meant for fixing the LV bushings. The LV jumpers and bushing material shall be selected and designed for this condition.

The design of the internal bushing for LV shall be such as to provided adequate earth clearance and creepage distance as stipulated in the standard specified. All other tests as per relevant standards shall be applicable.

The bushings shall be reputed make supplied by those manufactures who are having manufacturing and testing facilities for manufacture of HT insulators.

The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

The minimum phase to phase and phase to earth external clearances for HV & LV Bushings shall be as follows:

	Minimum clearances (in mm)	
	Phase to phase	Phase to earth
HV Bushings	130	80
LV Bushings	25	20

The above 140 mm. clearance does not apply to arcing horn gap.

15. CABLE BOXES ON LV & HV SIDE:

1. Cable boxes made up of HR sheet 2.5mm thickness with suitable handle and front cover to be provided for both HV &LV.
2. Water should not accumulate on cable boxes and proper slope shall be provided in order to ensure drainage of water.
3. Cable box protection shall be IP.55 Test reports to be submitted from NABL accredited Lab.
4. Cable box should be painted in same way as that of tank painting with treatment.
5. HV and LV cable boxes shall be fixed on opposite sides on the tank with nuts and bolts (gasket placed between them) in such a way that they can be completely removed whenever required.
6. Canopy shall be provided on all gasket joints, the bend edges of cover overlapping gasket to protect from rain and sunlight shall also accepted.
7. For HV cable box, Non – magnetic Gland plate shall have thickness of 4mm and shall be in two parts in such a way that HV cable can be easily removed.
8. For LV cable box, Non –magnetic Glade Plate shall have thickness of 4mm and shall be in two parts in such a way that LV cable cab be easily removed by removing the gland plates.
9. Gland Plates shall be mounted separately with nut & bolt arrangement and gasket in between them.
10. The supplier shall submit drawings for the box with internal details along with the transformer for approval.
11. The distance between LV gland plate and LV bushings centre should be minimum 400mm.

HV Cable Box:

a) The HV box shall be designed and fixed on transformer such way, that only opening of cover shall facilitate for working on cable termination with ease of accessibility of terminal.

b) HV box gland plate shall have single compression gland designed for 11kV, single run 3C x 95sq mm armoured cable as per drawing approval from BESCOM.

c) Earthing provision (Body earth outside and cable earthing inside of box) shall be provided in the HV box with M12 bolt.

d) Suitable Gland shall be provided with single compression brass gland (Gland shall be in the scope of supplier only).

e) The distance between HV gland plate and HV bushings centre should be minimum 300mm.

f) The HV bushings shall be so located that even under the coldest conditions the level of the transformer oil shall be above the HV bushings inside of the transformer tank.

LV Cable Box:

The transformer shall be fitted with suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression brass glands on LV side to terminate 1.1kV XLPE armoured cable. The LV cable box shall be made of Mild Steel (M.S.) sheet. The cable box shall have removable cover with handle. Suitable gasket of non – deteriorating rubber cork of similar material shall be provided at all joints to ensure tightness. The bottom plate of the LV dividing box shall be cut into two parts to facilitate removal of cables. The covers on the cable boxes shall be provided with suitable handles. The LV cable box shall be provided with aluminium busbar and shall be fitted with brass glands for LV cable. The LV busbar shall be supported using epoxy insulators from the top side the LV box. Length of the LV bus bar shall be sufficient for terminating 2 runs of 1.1kV class XLPE cable as per drawing approval from BESCOM.

Sl.No	Rating in kVA	Size of the Cable	Approx Dia of Cable
1	100kVA	3.5CX240sqmm	55mm
2	250kVA	3.5CX240sqmm	55mm
3	500kVA	3.5CX400sqmm	65mm

16. TANK BASE CHANNEL:

a) For 100kVA transformer 75 x 40mm channel.
b) For 250 KVA transformers 100 x 50mm channel.
c) For 500 KVA transformers 125 x 65mm channel.

Stiffeners (flats) shall be provided to tank base channels, along the length of the tank.

17. TERMINAL MARKING PLATE AND RATING PLATES:

The transformer shall be provided with a Anodized aluminium/stainless steel plate securely fixed on the outer body showing the relative physical position of the terminal and their markings. This shall be in accordance with IS: 1180(Part1):2014. The transformers shall be provided with rating plate furnishing the information as specified in 1180(Part1):2014.

The month and year of delivery shall be indicated on the rating plate. The rating plate shall be embossed / engraved type but not painted. The serial No. of transformer shall follow the code Nos. as detailed below. These shall be punch marked on the transformer tank and also on the top cover.

The Standard mark as given in column 1 of the First schedule of the licence shall be applied clearly and indelibly by stencilling/screen or ink jet printing/embossing/etching/engraving on the rating plate.

In addition, the BIS Certification Mark Licence No and reference to BIS website shall be clearly and indelibly marked on the rating plate.

18. FITTINGS:

The fittings on the transformers shall be as under.

1) Rating and Terminal marking plate - 1 No.

2) Earthing terminals minimum M12 with nuts should be provided on the tank - 2 Nos.

3) Lifting lugs for the complete transformer as well as for core & winding assembly - 4 Nos.
4) Cap for oil filling (on conservator) - 1 No.
5) Drain cum sampling valve (3/4" nominal thread size) with cover preferably steel with plug.
6) Conservator with drain plug - 1 No. (except for 25KVA).

7) Thermometer pocket - 1 No
8) Air release plug on main tank
9) Plat form mounting channels.
10) Unidirectional flat rollers
11) Inspection hole.
12) HV side neutral grounding strip(where one of the HV bushing terminal is connected to earth).
13) Pressure relief device or explosion vent.
14) Dehydrating breather : Silicagel breather of 250 gms for 100kVA, 500gms for 250 & 500kVA capacity.
15) Oil level guage shall be provided indicating 3 positions of oil marked as below:

Minimum (-)	-	5 degree C
	-	30 degree C
Maximum (+)	-	90 degree C

16) Off circuit tap switch handle shall be provided with locking arrangement.

17) HT & LT bushings- 3 Nos. of HT bushings and 4 Nos. of LT bushings shall be provided with terminal connectors. Each bushing of HV and LV shall be provided with 3Nos. of brass nuts and 2 Nos. plain brass washers for connecting terminal. LT terminal connectors for 250KVA and 500KVA transformers shall be supplied in a separate packing.

18) RADIATORS: Elliptical/fin/tubular type radiator shall be provided as per design.

19) Arcing horns for HT bushings with adjustable type on the ground side.

20) Filter valve - 20mm dia shall be provided on the upper side of the tank.

21) All the bolts/nuts/washers exposed to atmosphere shall be of steel with suitable finish like electro galvanized with passivation or hot dip galvanized.

19. TRANSFORMER OIL:

The transformer shall be supplied complete with first filling of New insulating oil Uninhibited(U) Type-II and tile same shall comply with IS: 335/2018 with latest revisions thereof and ageing characteristics specified.

a) **NEW OIL**:

Sl. No.	Characteristics	Unit	Guaranteed Data	
			Min	Max
1	Appearance		Clear free from sediment and suspended matter	
2	Density at 20° C	g/ml		0.895
3	Kinematic Viscosity at 40° C	mm²/sec		15
	at - 0° C			1800
4	Flash Point, PMCC	° C	135	
5	Pour Point	° C		-10
6	Inter Facial Tension at 25°C	mN/m	No General Requirement (40 min)	
7	Acidity	mq KOH/g		0.01
8	Water Content, Bulk/Drum, IBC	mg/kg		30/40
9	Breakdown Voltage			
	As delivered/ After Treatment	kV	30/70	
10	Dielectric Dissipation Factor (Tan □) at 90°C & 40 to 60 Hz			0.005
11	Corrosive Sulphur Silver Strip, 100°C, Hrs		Not Corrosive	
12	Potentially Corrosive Sulphur		Not Corrosive	

13	DBDS	mg/Kg	Not Detectable (<5 mg/kg)	
14	Total Sulphur Content	%	No General Requirement	
15	Inhibitors according to IS 13631/IEC 60666		(U) Uninhibited Oil Not Detectable (<0.01%)	
16	Metal Passivator additives according to IS 13631/ IEC 60666	mg/kg	Not Detectable (<5 mg/kg)	
17	Other Additives		Does Not contain any additives	
18	Oxidation Stability at 120°C, 164 Hrs			
	Total Acidity	mg KOH/g		1.2
	Sludge	%		0.8
	DDF at 90 °C			0.500
19	Gassing Tendency	µL/min	No General Requirement	
20	PCA Content	%		3
21	PCB Content	mg/kg	Not Detectable (< 2mg/kg)	
22	2- Furfural and related compounds content	mg/kg	Not Detectable (< 0.05 mg/kg) for each individual compound	
23	ECT		No General Requirement	
24	Particle Content		No General Requirement	

Remarks:

a) Value of 0.05% (max) shall be treated as absence of oxidation inhibitor.

b) The important characteristics of the transformer oil after it is filled in the transformer (with in 3 months of filling) shall be as follows.

c) All tests to verify the characteristics mentioned as above shall be carried out in accordance with IS: 335/2018.

20. TESTS:

Type tests, routine tests and acceptance tests shall be conducted on transformers, of each capacity. All the equipments offered, shall be fully type tested as per the relevant standards at CPRI/ERDA/NABL Accredited Govt. Labs and the date of type test will not be later than 5 years.

20.1 TYPE TESTS to be conducted on one Unit

The following shall constitute the type tests as per IS-1180 (Part I) and IS: 2026

1. Lightning impulse Test – IS 2026:2009 (Part 3) and 2shall comply with clause 14 of IS (Chopped Wave Testing).
2. Dynamic Short Circuit Test – IS 2026(Part5)

3. Thermal Short Circuit Test– IS 2026(Part5)

Note: Routine test before and after short circuit test shall be as per IS 2026(Part1)

4. Temperature- Rise Test (IS-2026 Part-2)

NOTE: Maximum measured total loss (No load at rated excitation + load loss at minimum current tap converted to 75degC reference temperature) at 100percent loading shall be supplied during temperature rise test.

5. Pressure Test – IS 1180(Part 1): 2014. (Clause No. 21.5)

NOTE: For every lot of 200 transformers (or less) offered for inspection, the type tests mentioned at clause (20.1) should be mandatorily conducted by choosing a random sample from the lot. If the offered lot is between 200-500 nos, atleast 2 samples shall be type tested. The entire lot shall be rejected if the sample fails the Type test. The testing charges shall be borne by the supplier

20.2 ROUTINE TESTS:

All transformers manufactured shall be subjected to the following routine test, at the manufacturer's works - In accordance with IS:1180(Part I): 2014 and IS:2026.

1) Measurement of winding resistance. – IS 2026(Part1)
2) Measurement of voltage ratio, polarity, phase sequence and check of voltage vector relationship IS 2026(Part-1).
3) Measurement of impedance voltage/short circuit impedance and load losses at 50% &100% at rated current and normal frequency. IS 2026 (Part1)
4) Measurement of No load Current and Neutral Current. IS 2026 (Part1)
5) Measurement insulation resistance. IS 2026(Part1)
6) Induced over voltage withstand test. IS 2026(Part3)
7) Separate source voltage withstand test. IS 2026(Part3)
8) Neutral current measurement: The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current. IS 2026(Part1)
9) Oil samples (one sample per lot) to comply with IS: 1866. IS 2026 (Part1)
10) Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.
11) Pressure and vacuum test for checking the deflection. IS 1180 (Part1):2014
12) Oil Leakage Test – IS-1180 (Part1): 2014.

NOTE: One out of the every consignment of the transformers received at stores, above Routine Tests shall be conducted mandatorily (at Stores). In case of failure, all the transformers in that consignment shall be tested and transformers which pass the test shall be accepted.

20.3 Type and Routine Test certificates:

1. One Transformer of tendered capacity, shall be fully type tested as per the relevant standards at CPRI/ERDA and the same shall be submitted along with the BID.
2. All Transformers manufactured shall be subjected to the routine test, at the manufacturer's work – in accordance with IS:1180(Part1):2014 and IS 2026.
3. Immediately after finalization of tile programme of type/ acceptance/ routine testing, the supplier shall give fifteen days advance intimation to the BESCOM to enable to depute its representative for witnessing the tests. The routine test certificate shall be submitted along with tile inspection offer.

20.4 ACCEPTANCE TEST:

At least 10% transformers of the offered lot (minimum of one) shall be subjected to routine/acceptance test in presence of BESCOMs representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS: 1180 and IS: 2026.

Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings.

Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report

Temperature rise test on one unit of the total ordered quantity.

All the assembled/ finished transformers prior to despatch shall be subjected to routine tests as per IS: 1180. The supplier shall invariably furnish manufacturer's routine test certificate along with inspection call of the offered transformers for pre-despatch inspection. The inspection offers without furnishing of routine test certificates as per ISS of all the transformers offered for final inspection shall not be entertained, and any delay on this account shall be to firm's account.

20.5 SPECIAL TESTS:

The following shall constitute the special test as per IS 1180 (Part-1) 2014 Amendment 4 to be conducted on one unit each capacity at CPRI/ ERDA/ NABL Accredited Govt. Labs and the date of special test will not be later than 5 years and shall be furnished.

a) Determination of sound levels IS 2026(Part 10).
b) No Load current at 112.5% voltage – IS 1180(Part1):2014.
c) Short Circuit with stand Test IS 2026 (Part 5) (Above 200KVA)

Note: Routine tests before and after short circuit test shall be conducted as per IS 2026 (Part-1)

d) Paint adhesion tests. The test is performed as per ASTM-D3359 (Standard Test methods for measuring adhesion by Tape test.

e) BDV & Moisture content of oil in the Transformer –IS-335.

20.6 RANDOM SELECTION AND TESTING (RST):

For every lot of 200 transformers (or less) offered for inspection, the type tests mentioned at clause (20.1) should be mandatorily conducted by choosing a random sample from the lot. If the offered lot is between 200-500 nos, atleast 2 samples shall be type tested. The entire lot shall be rejected if the sample fails the Type test. The testing charges shall be borne by the supplier

Further, Capacity Type test shall be conducted at CPRI, Bangalore at the cost of the supplier if required by BESCOM by selecting any one of the transformers from the supplied first LOT of 200 Nos at random from the stores. If the transformer fails in the capacity test, the offered lot will be rejected.

20.7 FAILURE IN TYPE TEST(S):

In the event of failure / unsatisfactory results of the transformer(s) in Dynamic & Thermal Ability to withstand Short Circuit Test / impulse type tests/ any other type tests, the supplier shall have to replace the supplies already made and no further transformers shall be accepted. The purchaser however, at his option, may accept the transformers already supplied with the following conditions:

i) Guarantee period of the supplied transformers issued to the field shall be increased by double the normal Guarantee period.

ii) Bank Guarantee shall be extended to cover the additional Guarantee period.

iii) For failure in any of the type tests listed under Clause (20.1), no further supplies shall be accepted.

iv) The transformers lying in the store(s) shall be replaced as per sub para (v) below.

v) The supplier shall, however, be allowed to check the reasons of failure and if need be, to improve / modify the design. Further supplies, including replacements against supplies already made, shall be accepted only after successful type test(s) are arranged on fresh transformer(s) selected by the authorized representative of the purchaser. All the type tests shall be arranged in case there is change in the design, otherwise, type test shall be repeated only for the test in which failure has occurred. Charges for such test(s) shall be borne by the supplier. However, in the event of failure of transformer in the repeat type test, the purchaser may take following actions:

a) Cancel pending orders of the rating in which failure(s) has occurred, &

b) Not place any order of Distribution Transformers on the firm for one / two year(s)

20.8 TESTING OF TRANSFORMERS AFTER DELIVERY TO BESCOM STORES

i) After pre-dispatch inspection of material at firm's works, the dispatch instructions will be issued for the respective store(s) as per requirement of BESCOM. Sample(s) will be drawn from the lot(s) received in store(s) and will be subjected to the following test(s):

One out of the every consignment of the transformers received at stores, above Routine Tests and **Measurement of total losses (at 50% & 100% loading)** shall be conducted mandatorily (at Stores). In case of failure, all the transformers in that consignment shall be tested and transformers which pass the test shall be accepted.

ii) The percentage impedance voltage at rated current shall not exceed the permissible limit of 4.5% with plus or minus 10% tolerance failing which the sub lot of transformers represented by the sample shall be rejected.

iii) The application of low voltage to the middle limb will induce approximately equal voltages on the two end limbs. The application of voltage to the end limbs will induce greater voltage in the middle limb and less voltage in the other end limb. Uniformity of induced voltages shall confirm the healthiness of the transformer windings.

The procedure for the test shall be as under:

a) Apply 250 Volts between LV terminals-2u-2n and measure voltages between 2v-2n & 2w –2n.

b) Apply 250 Volts between 2v-2n and measure voltages between 2u-2n & 2w-2n.

c) Apply 250 Volts between 2w-2n and measure voltages between 2u-2n & 2v-2n.

The measured voltages shall satisfy the conditions detailed as above.

21 TOLERANCES:

Unless otherwise specified herein, the values of different parameters of the transformers supplied shall be within the tolerance permitted in the IS-2026 on the guaranteed values. Positive tolerance is not applicable for losses and negative tolerance not applicable for cross sections of winding specified.

22 FINISHING:

The exterior of the transformer tank and other ferrous fittings shall be thoroughly cleaned, scrapped/sand blasted and given a priming coat and two finishing coats of durable oil the weather resistance paints or enamel. The colour of finishing coats for transformers shall be as follows, as per IS: 5.

a) For 100 kVA - Brilliant Green shade No.221

b) For 250 KVA - } Dark admiral grey shade No. 632

c) For 500 KVA - }

23 GUARANTEED TECHNICAL PARTICULARS:

The guaranteed technical particulars as per Annexure I & II to be filled and submitted by the Tenderer. The transformers to be supplied against this order shall have the value as per Technical specifications. Any deviation in GTP mentioned should be furnished in deviation schedule separately (Annexure-III).

24 DOCUMENTARY EVIDENCE:

The successful supplier shall have to furnish the routine test certificates along with the central excise gate pass and the purchase invoices for the purchase of CRGO sheet, core material, oil and aluminum wire, bushings, steel (required for fabrication of the transformer tank) etc., at the time of routine testing of the fully assembled transformer.

25 TESTING FACILITY:

The supplier shall have adequate testing facility to conduct the routine tests.

26 QUALITY ASSURANCE PLAN:

In respect of raw materials such as core stamping, winding, conductor, insulating paper and oil, the manufacturer shall use these materials manufactured/supplied by the standard manufacturers and furnish the manufacturers test certificates as well as the proof of purchase from these manufacturers (excise gate pass) for information of corporation.

The supplier shall invariably furnish following information along with his offer, failing which his offer, shall be liable for rejection.

Statement giving list of important raw materials including but not limited to :

a) Core material
b) Winding material
c) Insulation paper and press boards.
d) Transformer oil
e) Bushings
f) Tanks, conservator and radiators

Names of sub supplier for the raw materials, List of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in presence of Supplier's representatives, copies of test certificates.

1. Information and copies of test certificates as in (1) above in respect of bought out accessories.
2. List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspections.

3. Special features provided in the equipment to make it maintenance free.

4. List of testing equipment available with the supplier for final testing of transformers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. The limitations shall be very clearly brought out in the relevant schedule i.e., schedule of deviations from specified test requirements.

The supplier shall within 30 days of placement of order, submit following information to tile purchaser.

a) List of raw materials as well brought out accessories and the names of sub suppliers selected from those furnished along with offer.

b) Type test certificates of the raw material and bought out accessories.

c) Quality Assurance Plan (QAP) with hold points for purchaser's inspection. The quality assurance plans and hold points shall be discussed between the purchaser and supplier before the QAP is finalized.

The supplier shall submit the routine test certificate of bought out items and raw material, at the 6mm of routine testing of the fully assembled Transformer.

27 INSPECTION:

The supplier shall give 10 days advance intimation to the purchaser to organize stage inspection of the Transformer in which the assembly of core and the winding could be inspected. The BESCOM may at its option, open a transformer supplied to the stores, in the presence of the successful tenderer at site or at BESCOM stores. If any of the technical particulars are seen to be at variance with the guaranteed technical particulars the whole lot of transformers will be rejected and risk purchase resorted to.

27.1 INSPECTION AND TESTING OF TRANSFORMER OIL:

To ascertain the quality of the Transformer oil, the original manufacturer's test report should be submitted at the time of inspection. Also arrangements shall be made for testing of Transformer oil, after taking out the sample from the manufactured Transformer and tested in the presence of BESCOM's representative or in any independent laboratory viz., B.D.V. test should be conducted in presence of BESCOM representatives.

27.2 GUARANTEE:

The manufacturers of the transformer shall provide a guarantee of **5 years from the date of supply**. In case the distribution transformer fails within the guarantee period the purchaser will immediately inform the supplier who shall take back the failed DT within 15 days from the date of the information at his own cost and replace / repair the transformer within forty five days of date of intimation with a roll over guarantee.

The outage period i.e., period from the date of failure till unit is repaired/ replaced shall not be countered for arriving at the guarantee period.

In the event of the supplier's inability to adhere to the aforesaid provisions, suitable penal action will be taken against the supplier which may inter alia include blacklisting of the firm for future business with the purchaser for a certain period.

28 DOCUMENTATION:

28.1 All drawings shall conform to international standards organization (ISO) 'A' Series of drawing sheet/Indian standards specification IS:656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in SI Units.

28.2 List of typical Drawings and Documents :

1) DT1 – General drawing showing internal clearance dimensions and active parts.
2) DT2 – Dimensional sketch for 250KVA & 500kVA Transformers.

28.3 The suppliers should manufacture and supply the transformers strictly as per the specifications only, and no deviations are permitted.

The supplier shall furnish all the details of constructional feature showing tile details of all the items in the plan, sectional elevation and tile side elevation and indicate these details/dimensions.

28.4 The supplier shall furnish the magnetization characteristic curve for the core material of the transformer.

28.5 Two sets of the type test reports, duly approved by the BESCOM shall be submitted by the supplier for distribution before commencement of supply.

28.6 The manufacture of the equipments shall be strictly in accordance with the approved drawings and no deviation shall be permitted without written approval of the Corporation. All manufacturing and fabrication work in connection with the equipment prior to the approval of tile drawing shall be at tile suppliers risk.

28.7 Approval of drawings / work by BESCOM shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirement of the latest revision of applicable standards, rules and codes of practices. The equipments shall conform in all respects to high standards of engineering design workmanship and latest revisions of relevant standards at the time of supply and the BESCOM shall have the power to reject any work or materials which in his judgment is not in full accordance there with.

29 PACKING AND FORWARDING:

Each consignment shall be accompanied by a detailed packing list containing the following information.

a) Name of the Consignee.
b) Details of Consignment.
c) Destination.
d) Total weight of consignment
e) Signs showing upper / lower side of the crate.
f) Bill of Materials including contents of each package.

The monogram/name of the firm shall be blanked on the top cover of the Transformer.

30 PUNCH MARKING OF TRANSFORMER SERIAL NO.

The serial No. of the Transformer shall be punch marked on the transformers tank and also on the top cover in addition to that indicated on the name plate as per relevant clause.

31. SEALING:

The necessary provisions shall be made by the manufacturers for sealing diagonally opposite to the top cover & body (2 sides) and also name plate of the transformers.

32. Unique ID Code: Unique ID plate along with Unique ID code shall be provided.

33. COST ANALYSIS: The supplier shall furnish "Cost Analysis" sheets for each rating of Transformer

General Manager (El.)
Quality Standards and Safety,